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## Densification and purification of foamed polystyrene waste for recycling, by dissolution in specific solvent, e.g. alkylene glycol dialkyl ether, and precipitation, preferably with alcohol

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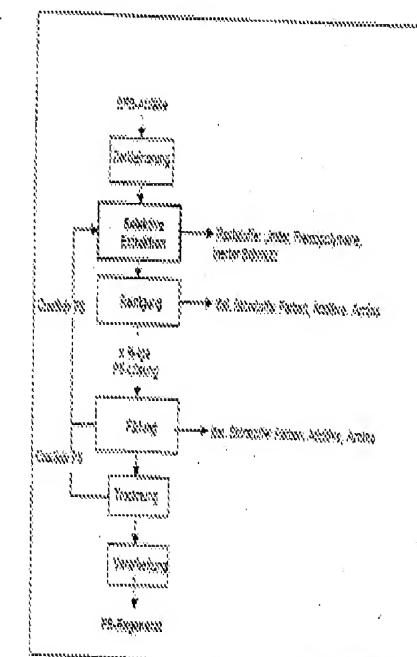
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### Abstract of DE10207336

Purification of foamed polystyrene (PS) waste (I) involves: (a) dissolving (I) in a solvent selected from (1-12C) alkylene glycol di-(1-12C) alkyl ethers, (1-12C) mono- or dicarboxylic acid di-(1-12C) alkyl esters, tetrahydrofuran and mixtures of these solvents with each other or with ethylene carbonate, propylene carbonate and/or rape oil methyl ester; (b) mixing the solution with a precipitant for PS which dissolves halohydrocarbon flame retardants; and (c) separating and optionally partially or completely drying the precipitated PS.



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1. Method for cleaning foamed polystyrene wastes, characterized by the following steps:
  - a) Solve the foamed polystyrene wastes in a solvent, selected under the-niederalkylenglycol those-niederalkyl-ethern with Niederalkyl (EN) equal if geradkettiges or branched C1-C12-Alkyl (EN), mono or dicarbonic acid the down alkyl star with a straight or branched carbonic acid chain length from c1 to C12, where the expression ?Niederalkyl? the same importance, as leading for the Glykoether described, possesses, THF, mixtures of the aforementioned solvents and mixtures of these solvents with ethyl carbonate, propylene carbonate and/or rapeseed oil methyl ester;
  - b) Mix the polystyrene solution with a drop means for polystyrene, which solves usual as flame protection means used, halo genius ores of hydrocarbons;
  - c) Separation and if necessary. partial or complete drying of the gefällten polystyrene.
2. Process according to claim 1, characterised in that the drop means selected is preferential under alcohols, in particular under geradkettigen or branched C1-C5-Alkanolen and completely particularly under such C2-C4-Alkanolen.
3. Process according to claim 1, characterised in that the drop means further a blowing agent for polystyrene contains.
4. Process according to claim 3, characterised in that the separated polystyrene one foams.
5. Process according to claim 1, characterised in that the separated polystyrene is converted to molded articles.

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The instant invention concerns a procedure for collecting, cleaning and reusing of foamed polystyrene wastes.

Foamed plastics, so-called, if polymer foam expanded, due to their small density as well as their mechanical and thermal characteristic profile (in particular good isolation ability) often into packing and applications of buildings are used. Considering the very large marketed quantities and the variety of established applications expanded polystyrene (EPS) is the polymer foam leading the market.

EPS is manufactured by suspension polymerization by styrene under addition by blowing agents, like down-simmering alkanes, above all pentane. Later a-polymerized or on the Perl surfaces fixed, organic bromine connections (Hexabromcyclododecan, Pentabromphenylallylether and. A.) work as flame protection means and result in flame resistant or self-extinguishing insulating materials (z. B. the building material class B1 according to DIN 4102).

EPS has itself and. A. in applications of buildings, as packing material and as transport containers in various applications proven and for these purposes also to large extent one uses.

The disposal of the large volume foam material parts is problematic. Therefore for the solution of this task of recycling for clean or only EPS contaminated with foreign polymers plastic waste mixtures were published so far a variety from suggestions to dissolving the EPS in a solvent with the goal of the volume reduction. Unfavorably are due to their classification as dangerous materials the so far suggested, marking-requiring, aromatic (see z. B. US 5.278.282) or halo genius ores solvents (see US 4.517.312, US 5.891.403).

Also different suggestions, in which without these critical solvents one does, use marking-requiring solvents, like Limonen (US 5.223.543, after the dangerous material regulation PCT/US93/09989), so that for collection, transport and disposal of the plastic solutions more elevated, safety-relevant expenditure must be operated.

Finally also the EP calls 739,930 A1 a set of solvents, in which polystyrene foamed separates, in order to reduce its volumes. It concerns thereby Glykoletherverbindungen as well as dicarbonic acid esters.

To very large extent EPS transport containers in the food trade (EPS poultry Tray) are used. In particular also as containers for sensitive food, z. B. Fresh fish and meat, are used EPS shaped parts in the framework by cool or cold treatment transportation. The disposal, of the large volume foam material parts here resulting is particularly problematic, there it after use with foreign materials and arrears of the cargoes, z. B. strongly smelling fish remainders, are contaminated.

In the context of a high-quality, material recycling these plastic wastes are thus not applicable due to large disturbing off contents. After due to the low bulk density energetically complex a transport to the collecting points and afterwards further to the disposal and/or. Removal enterprises these

materials are usually thermally treated or deposited therefore.

Task of the instant invention is it to make a procedure available with its assistance the foamed polystyrene not only space saving solved and if necessary. again pleases will can, but in which impurities, like foreign polymers, contamination, filling material arrears, other contamination originating from collecting the residual substances as well as if necessary. also additives, as coloring materials and flame protection means can be separated, from the polymer.

This task is solved by dissolving the foamed EPS wastes in a suitable solvent and cases from polystyrene by mixing with a drop means for polystyrene, which possibly existing, usual foreign polymers, flame protection means and such, in particular in addition, smell-troubling contamination, as holds amines, in solution.

According to invention from contaminated post office consumer wastes high-quality products are created by the procedure, which can be material recyclelt.

The procedure consists of three steps:

Dissolve the plastic, precipitation with a suitable drop means and following separation and if necessary. The partialdry gefällten polymer particle. If necessary the quality of the precipitated polymer can being improved regarding color, soluble contamination, like amines, food and filling material arrears or additives, like flame protection means, in an intermediate step by physicochemical cleaning stages (filtration or such) and/or a selective precipitation; also the molecular weight distribution can if necessary. are improved.

Also techniques and procedures can be used from DE 41 19 303 A1 (selective precipitation).

Improvements and advantages opposite the state of the art

It takes place a volume reduction around for instance the factor 20, the transportation expenditures saves.

The assigned solvents and/or main components of the solvent mixtures are after European Union directive 1999/13/EC article 2 (17) non VOC.

A material recycling of the strongly gotten dirty and fremdpolymerhaltigen post office consumer wastes succeeds.

The strong smell in EPS Fischbox wastes is eliminated, likewise protein remainders and. A. of meat wastes.

The usually used, bromierten FR-additives and coloring materials can be reduced efficiently. The depletion amounts to with application of the selective precipitation well over 95%.

The remaining pentane content (blowing agent) in the EPS waste becomes just like HP in the material recycling cycle the maintained.

It does not take place a thermal-mechanical load of the polystyrene, concomitantly no material damage and no molecular weight dismantling. The original polymer characteristics remain.

When preferably a solvent or a solvent mixture used solvents for the EPS, as it is described in the EP mentioned already above 739,930 a2, or a similar solvent (mixture), so above all a Glykolether, preferably a the-niederalkylenglycol-those-niederalkyl-ether with Niederalkyl (EN) equal geradketiges or branched C1-C12 alkyl (EN), preferably equal C1-C4-Alkyl (EN) and more strongly prefers a Diethylen or the-propylenglycol-those-more niederalkylether with C1-C4-Alkylgruppen, or a mono or a dicarbonic acid those down alkyl esters with a straight or branched carbonic acid chain length from c1 to C12, vozugsweise from c1 to C4, where the expression ?Niederalkyl? possesses the same importance, as leading for the Glykolether described. Also mixtures can be inserted by Glykolethern, by mono carbonic acid alkyl star, by dicarbonic acid alkyl star or by Ethern with esters. As Glykolether Dipropylenglykolmethyl or - ethylether, Diethylenglykolmethyl or - ethylether are well suitable. Well suitably as carboxylic esters are dicarbonic acid methyl, - ethyl and - more isobutylester and here in particular Glutarsäuredimethylester, Bernsteinsäuredimethylester and Adipinsäuredimethylester as well as their ethyl and Isobutyl analogues, as well as ethyl acetate. Above all the dicarbonic acid esters, in particular the three

dicarboxylic acid esters in particular mentioned, specified above, can be used also in mixture with propylene carbonate, ethyl carbonate or rapeseed oil methyl ester. If necessary, even if tetrahydrofuran, however or in mixture with or several of the aforementioned connections, can be used.

As drop means preferably down-simmering is suitable and/or, at ambient temperature liquid alcohols, like ethanol, n and isopropanol or gerakettiges or a branched Butanol. Isopropanol and/or ethanol are particularly well suitable.

Preferably the precipitation of the polystyrene takes place via the fact that the drop means is submitted and the solution of the EPS in one of the solvents mentioned is carefully cast into the agitated collecting main, whereby it is particularly favorable to hold the turbulences in such a way that kleinteilige particles form. Frequently fiber-forming particles develop.

In a particularly preferred arrangement the drop means consists pentane or a mixture of the aforementioned alcohols as well as a down-simmering alkane, in particular. The pentane is likewise a drop means for polystyrene; with cases it is incorporated into the polystyrene particles with. If these are afterwards only carefully part-dried, pentane in them, which can be used then to reconstitute foams, remains. Reconstituted foams can take place in the hot-air furnace with 100 DEG C.

#### Remark example

▲ top As typical post office consumer EPS wastes three different qualities were regenerated:

- EPS waste, cleanly, does not inject;
- EPS waste, cleanly, thermally densified;
- EPS waste from fish packing, strongly smelling, thermally densified.

The following table summarizes the beginning quantities:

#### EMI 6.1

First the three samples under occasional agitating are loosened in the quantities of solvent indicated in each case. One receives the assigned solvent from 85% of a mixture out:

55-65 Gew. - % Glutarsäuredimethylester,  
15-25 Gew. - % Bernsteinsäuredimethylester and  
10-25 Gew. - % Adipinsäuredimethylester, also  
15% Dipropylenglycoldimethylether was together-given.

In each case after 24 hours unresolved arrears are separated over a 0,125-mm-Sieb and the filtered solutions in ISO Propanol are precipitated. In addition a collecting main with 5 becomes and/or, as well as 3 kg of ISO Propanol fills with agitator and flow resistances turbulent agitated. The EPS solutions become with a river of approx. 50 g/min carefully into these agitated collecting mains given. Form short, threadlike EPS particles, which afterwards light over a 0,125-mm-Sieb can be filtered off. Since the EPS Fällprodukte exhibits still larger solvent arrears, they are washed afterwards in a cutting platform 3mal with ISO Propanol. Between the individual laundry the products are pressfiltered in each case. The solvent quantities used to the laundry correspond to the damp weight of the product which can be washed with the first two laundry; with the third laundry the double quantity is used.

Subsequently, the products are dried over night with 60 DEG C in the oven and cut up afterwards in the cutting platform. From these product samples clear press foils are finally provided (10 s, 10 bar, 120 DEG C).

The remainder solvent content determined by means of Headspace office is with 0,1%. The gel permeation chromatography of the three EPS wastes and in each case from it after 0, used for mol mass regulation. g. Procedure manufactured EPS Recyclaten confirms the receipt of the molecular masses. With the fact this result occupies that the polymer chains are not damaged by the recycling process and the original polymer quality remains.